

Impact of surface heterogeneities on the fog life cycle during the SOFOG3D fog experiment

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Experimental data

Measurements set-up

The SOFOG3D measurement campaign is:

- 6 months periods (from November 2019 to March 2020)
- 34 sampled fog episodes
- 15 IOPs
- 70 x 20 km² area
- 17 observation sites elevated from 28 m to 110m

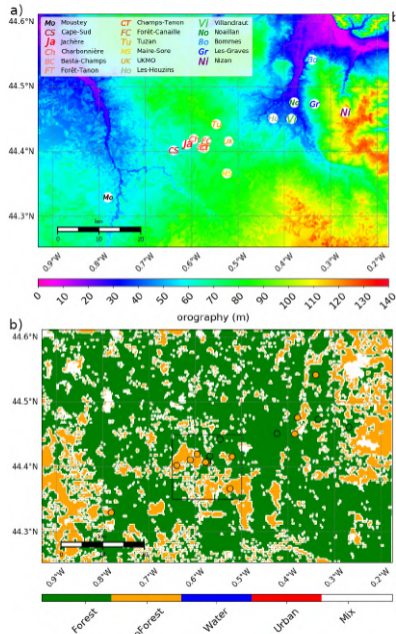


Figure: color: ECOCLIMAP-SG database / circle: dominant Goggle-Earth cover

Experimental data

Comparison between **forest** and **non-forest** sites from the whole measurement database

Night fog occurrences

No impact on the fog occurrence of:

- longitude
- altitude
- vegetation cover

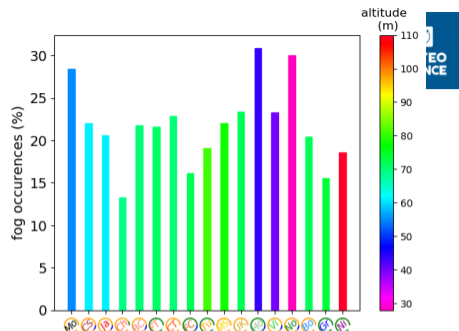


Figure: Stations from West to East, with Forest and Non-Forest

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Caution

More measurements in the 2nd part of the winter

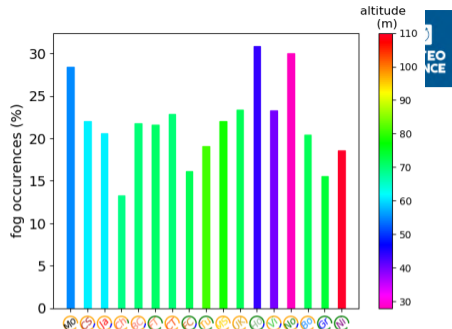
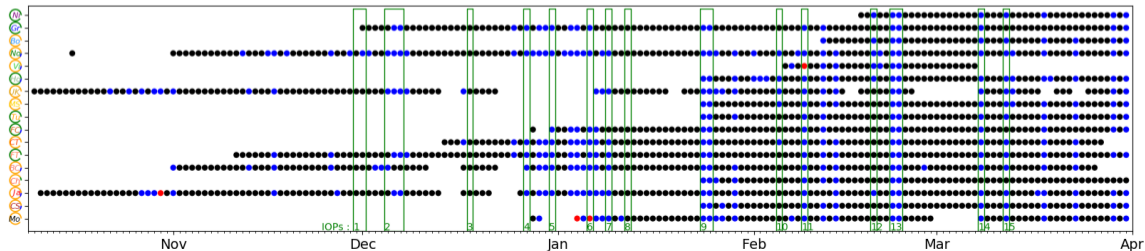
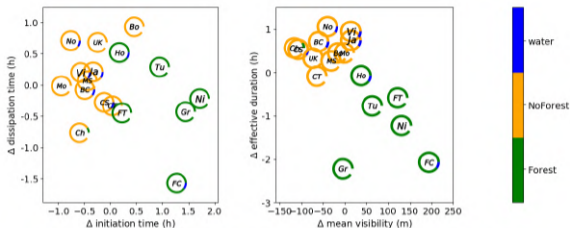


Figure: Stations from West to East, with Forest and Non-Forest



Experimental data

Comparison between **forest** and **non-forest** sites from the whole measurement database

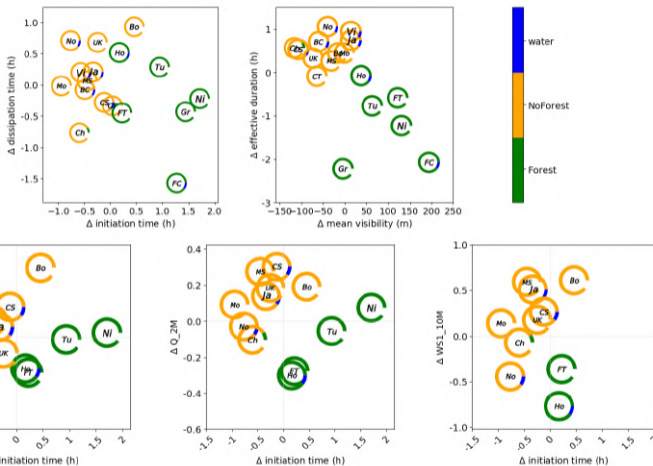


- Delayed initiation on forest sites
- No impact of ground cover during dissipation
- Shorter fog durations in forest
- Higher visibilities (3m) in the forest

Figure: Average deviation from the mean state during each fog episode at the different sites represented by their initials. The pie chart surrounding each initial represents the vegetation cover distribution within a 100m radius around the measurement point.

Experimental data

Comparison between **forest** and **non-forest** sites from the whole measurement database



- Delayed initiation on forest sites
- No impact of ground cover during dissipation
- Shorter fog durations in forest
- Higher visibilities (3m) in the forest
- Lower temperatures, humidities and wind speeds at the forest sites during the three hours preceding the fog formation

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Simulation analysis

Numerical set-up and sensitivity tests

Meso-NH (Lac et al., 2018) configuration on the most documented IOP (**6-11-14**):

- Initialization / Coupling: AROME-ARPEGE analyses or AROME-IFS forecasts
- Run 2-way grid nesting **500m** (300×180 pts) to **100m** (600×400 pts)
- 138 vertical levels (71 from 3m to 1km)
- Convective scheme: EDMF (Pergaud et al. 2009) for 500m domain
- EcRad
- Orography: SRTM 90m (dad 500m) 30m (son 100m)
- Land cover, surface : ECOCLIMAP-SG databases
- Turbulence: 1D at 500m, 3D at 100m (Cuxart et al. 2000)
- 2-moment microphysics: LIMA (Vié et al. 2016)
- Subgrid condensation scheme at 500m

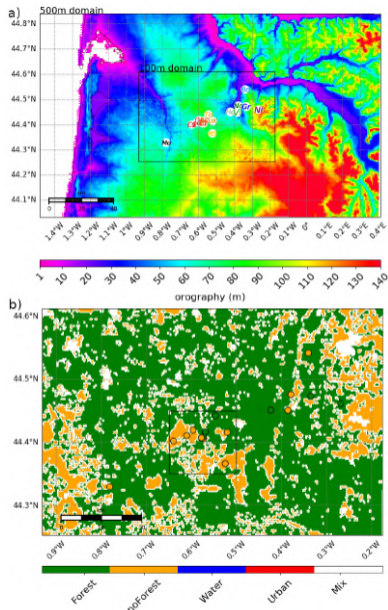


Figure: a) orography over the 500m resolution domain, and b) ECOCLIMAP-SG (300 m) databases over the 100m resolution domain

Simulation analysis

Sensitivity tests to measure the impact and define the best configuration

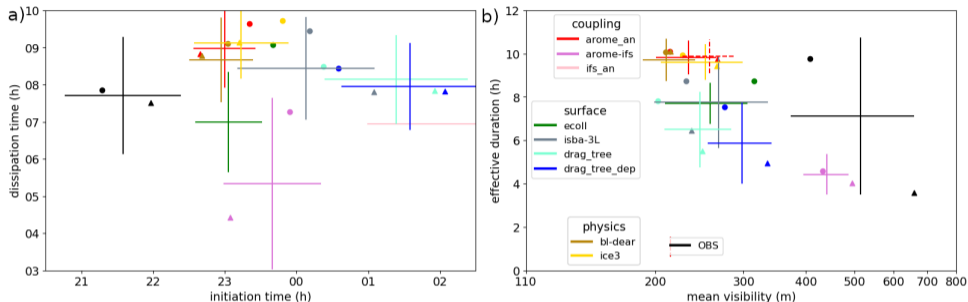


Figure: a) all sites mean variability initiation versus dissipation time of fog, and b) mean variability of the visibility versus effective duration of the fog episode for observed available sites (black cross). The mean value for forest sites is represented by a triangle and by a point for other sites.

Coupling files

- AROME-ARPEGE analyses
- AROME-IFS forecast
- IFS

Physics

- Mixing length: BL89 (500m)
DEAR (100m) vs HM21 (both)
- Microphysics: ICE3 vs LIMA

Surface

- ISBA-3L vs ISBA-DIF
- ECOCLIMAP-II vs ECOCLIMAP-SG
- Tree drag
- Tree drag + tree deposition

Simulation analysis

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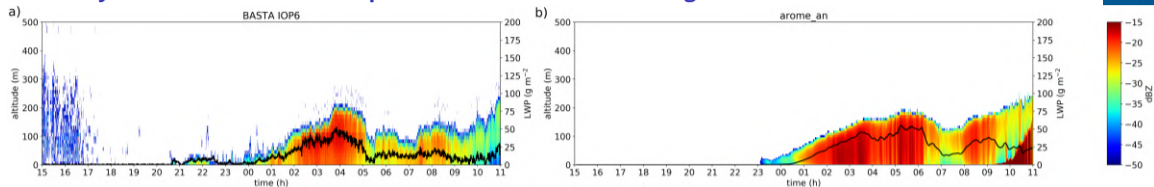


Figure: Temporal evolution of a) observed and b) simulated reflectivities (colors) by the vertical (logscale) doppler radar BASTA, and the total liquid water path (black line) from the HATPRO microwave radiometer

- The simulated reflectivity profiles are relatively close to the observations
- The simulated LWP is more important

Simulation analysis

Sensitivity tests to measure the impact and define the best configuration

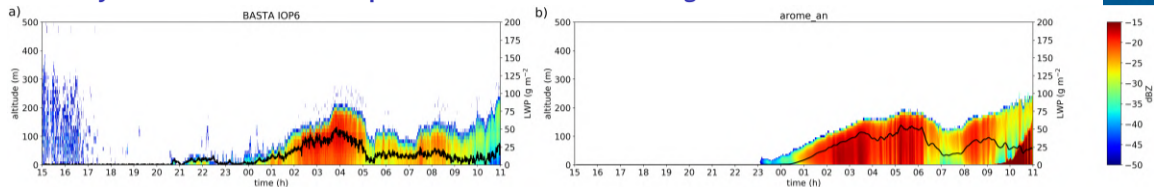
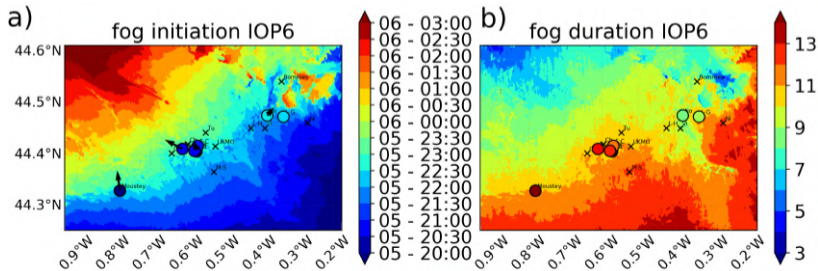


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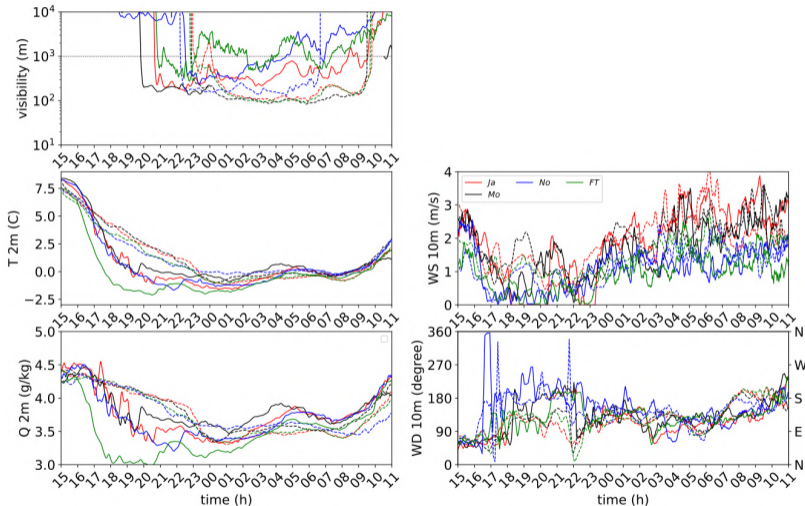


Figure: Temporal evolution of **observed (plain lines)** and **simulated (dashed lines)**: a) visibility (m), b) 2 m temperature (degree Celcius), c) specific humidity (g/kg), d) and 10 m wind speed, from West to East at Moustey, Jachère, Forêt Tanon and Noaillan sites.

The model successfully reproduces the meteorological situation leading to fog formation: cooling, lower humidity, wind speed

- The cooling is too slow
- Delayed fog initiation
- Variability at the initiation and dissipation slightly underestimated

Simulation analysis

Difference Forest/non Forest in the 100m simulation for all the grid points

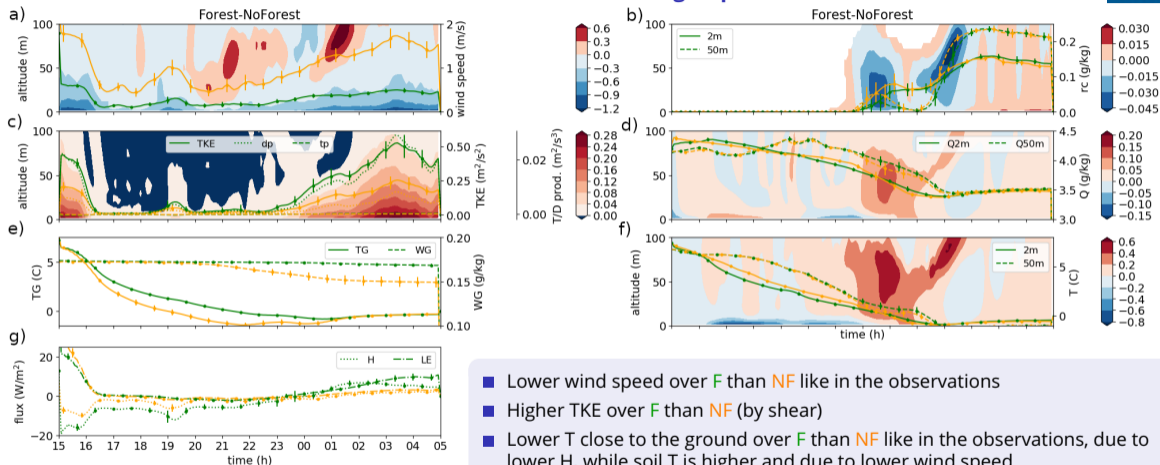


Figure: Averaged and differences (colors) of Forest (green) and NoForest (orange) grid points (over 80%): a) 10m wind speed b) droplets mixing ratio (2m, plain line, and 50m dashed line), c) 2m TKE (plain line), and its thermal (dashed lines) and dynamical (dotted lines) production, d) specific humidity, e) ground temperature (plain line) and humidity (dashed line), f) temperature, and g) Sensitive (plain line) and latent (dashed line) heat flux.

- Lower wind speed over **F** than **NF** like in the observations
- Higher TKE over **F** than **NF** (by shear)
- Lower T close to the ground over **F** than **NF** like in the observations, due to lower H, while soil T is higher and due to lower wind speed
- Lower humidity close to the ground over **f** than **NF** before fog initiation like in the observations even if LE is similar due to lower wind speed
- Cloud content is lower over **F** than **NF** like in the observation

Analysis of the 6 months campaign measurements

- Delayed fog initiations for the forest sites with higher visibilities
- Lower temperature, humidity and wind in forest sites

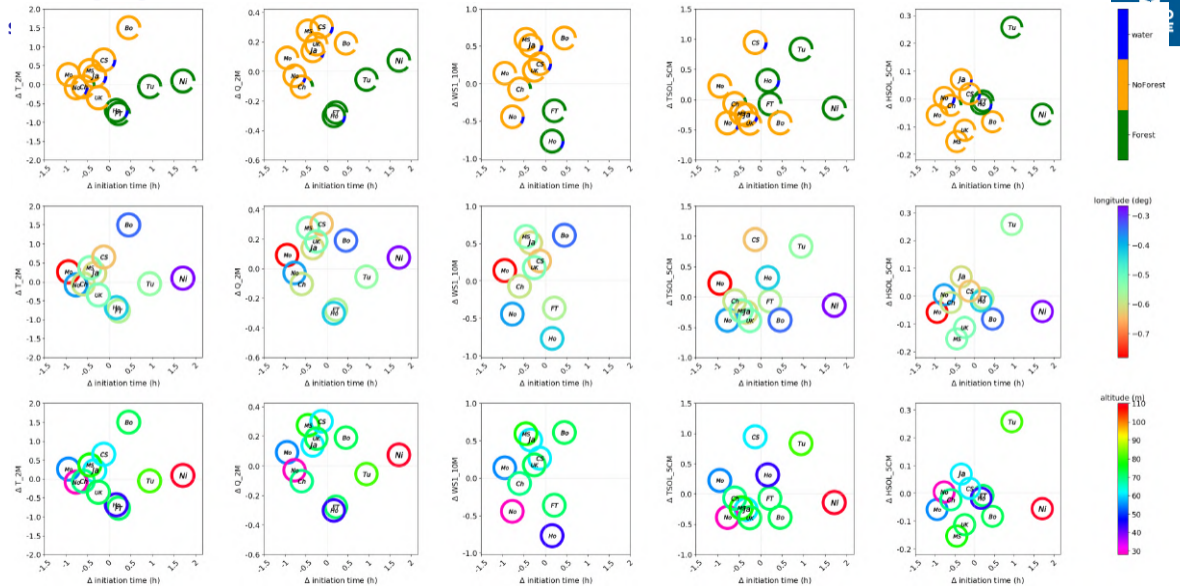
IOP simulations

- Sensitivity tests: strong impact of large-scale conditions on the fog cycle then the surface representation and physical parameterization
- Impact of the F/NF cover slightly underestimated in the simulation, probably due to insufficient spatial resolution
- But the F/NF distinction over all the grid points allows to reproduce the observations results and to better understand:
 - The lower H in F explains the lower T
 - The lower wind probably explains the lower cloud content
 - In agreement with Mazoyer et al.(2017) with a sheltering effect near the trees reducing the wind and increasing the TKE

Curently : Writing of a paper for QJRMS

Questions? Comments?

Annexe

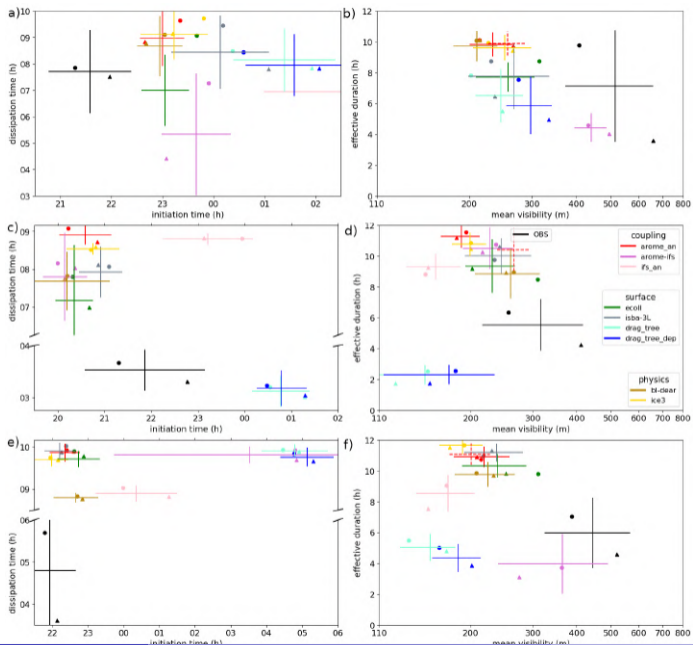


	Mo	CS	Ja	Ch	BC	FT	CT	FC	Tu	MS	UK	Ho	Vi	No	Bo	Gr	Ni
obs	NF	NF	NF	NF	NF	F	NF	F	F	NF	NF	F	NF	NF	NF	F	F
eco-SG	NF	NF	NF					F	NF	NF	F	F	F		F	F	F
eco-II			NF						F	F	F						

Table: Dominant (higher than 80%) land cover (F for Forest, NF for NoForest) observed within a 100m radius and obtained from the ecoclimap version II and ecoclimap second generation databases over the 100m on the simulation domain at 100m resolution.

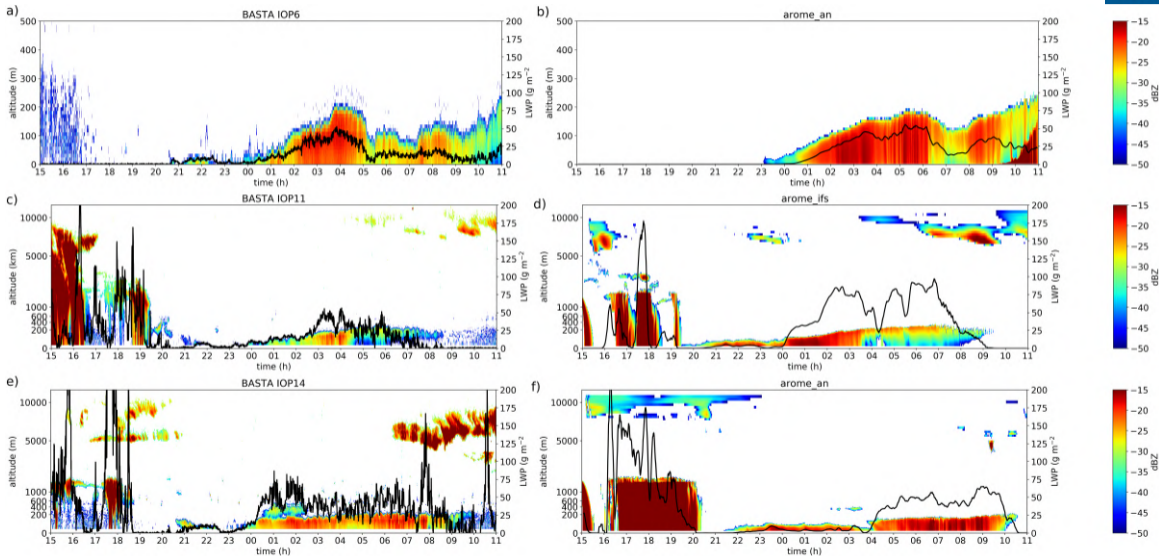
Annexe

Simulations



Annexe

IOPs reflectivities

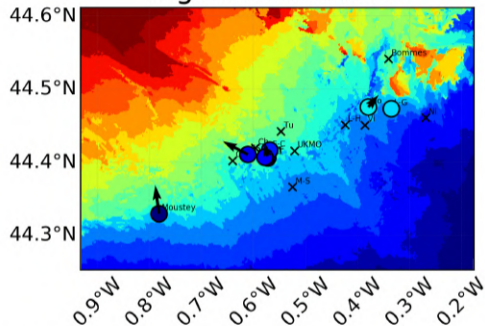


Annexe

IOPs reflectivities

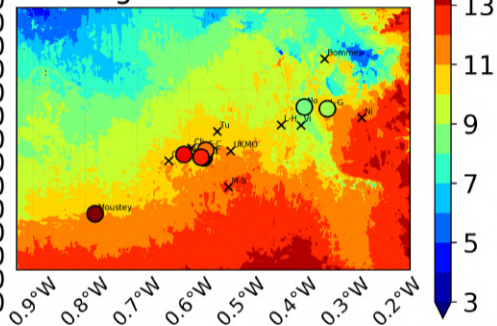
a)

fog initiation IOP6



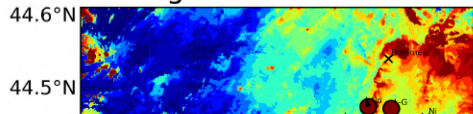
b)

fog duration IOP6



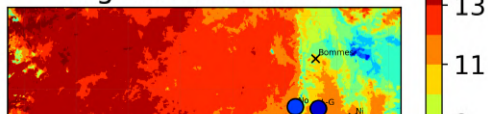
c)

fog initiation IOP11



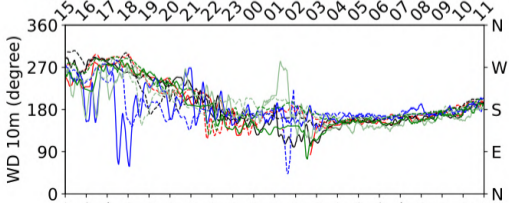
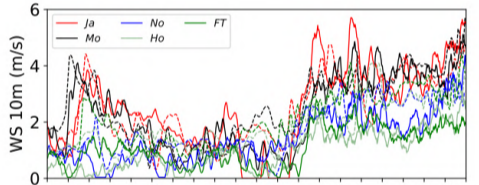
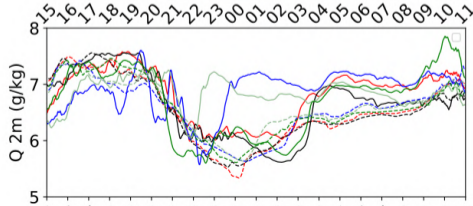
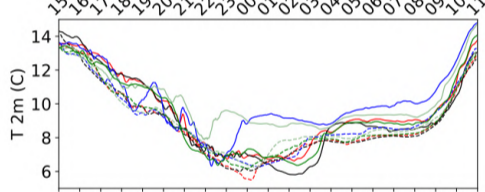
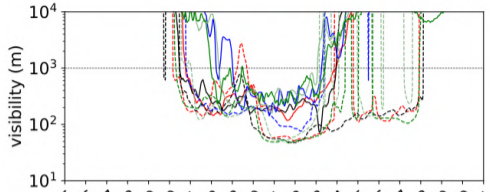
d)

fog duration IOP11



Annexe

IOP 11



Annexe

IOP 14

